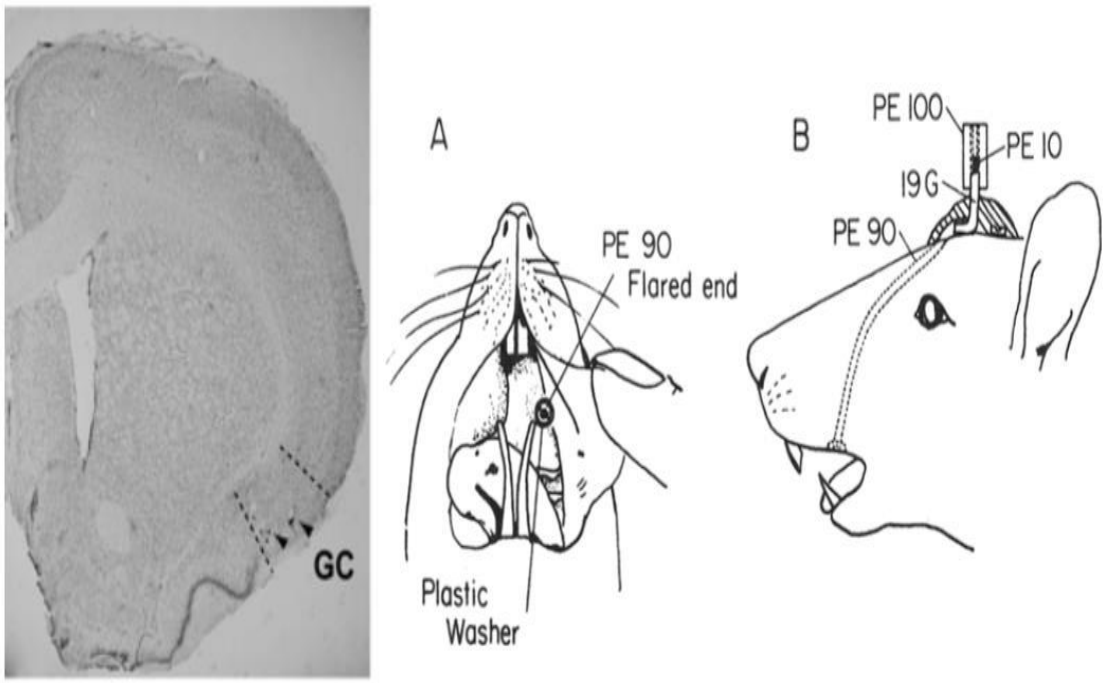
Signal Analysis/ Prof. Adriano Tort / April 21th, 2021

List of exercises 5 (2nd course assessment)

Dataset: *GC_LFPs.mat*

Sampling rate: 1000 Hz



Experimental protocol: the *.mat* file contains local field potential (LFP) recordings from the gustatory cortex (GC) of rats experiencing different flavors from liquid samples administered over their tongues via an intraoral canula. There are 144 trials of 3.5 seconds each, based on the following protocol: 1 second of basal activity followed by 2.5 seconds of post-taste activity. That is, on each trial the liquid sample is administered after 1 second of recording. The LFPs of the file are stored in a 144x35000 matrix (trial number x time samples).

Write a script to analyze this data in a way that answers the questions below. For each question, create a separate code block inside your script. Whenever applicable, write a comment to indicate which question is being answered in which block of code. Your scripts should also present plots that are as aesthetically pleasing as possible (i.e., with names for axis/groups, color resources, etc.).

Questions

1) (0.05) Compute and plot the event-related potential (ERP). Use a dashed vertical line to indicate stimulus time.
2) (0.15) Compute the mean auto correlogram (ACG) (over trials) for the basal period (0-1 s), for the first second after administering the liquid sample (1-2 s), and for the 2º second (2-3 s). Next, show in different subplots the mean ACGs for each of these periods. Use “basal”, “early post-taste” and “late post-taste” as titles.
3) (0.1) Compute the TFD (*time-frequency decomposition*) of the ERP from 1) using a continuous wavelet transform. Use the Morlet wavelet and a frequency vector defined

by 4:0.2:20 Hz. Plot the results on subplot (2,1,1) and use a dashed line to indicate stimulus time.

4) (0.2) Compute wavelet transforms and TFDs as above, but for each trial individually. Next, plot the mean TFD on subplot (2,1,2) and use a dashed line to indicate stimulus time.
5) (0.1) Filter each trial on the 8 to 12 Hz frequency range and plot its amplitude envelope alongside the mean filtered signal. Use a dashed line to indicate stimulus time.
6) (0.1) Filter each trial on the 8 to 12 Hz frequency range and compute its amplitude envelope. Use a dashed line to indicate stimulus time.

(Bonus question 1) (0.1) Plot the mean amplitude ± one standard error of the mean (SEM), where SEM is defined as the standard deviation (SD) divided by the square root of the number of trials.

(Bonus question 2) (0.1) Compute the basal value of the mean amplitude as well as its standard deviation (SD), using the period from 200 ms to 800 ms. Plot continuous horizontal lines of the basal amplitude values ± two SD.

7) (0.15) Filter each trial on the 8 to 12 Hz frequency range. Compute and plot in (2,1,1) the instantaneous phases from the mean filtered signal, using the first 1.5 seconds after stimulus as X axis limits. Next, compute the instantaneous frequency of the mean filtered signal and plot in (2,1,2) using 8 to 12 as Y axis limits and the same X axis limits as before (first 1.5 seconds after stimulus).
8) (0.15) Compute and plot the inter-trial coherence (ITC) values for the 8 to 12 Hz frequency range.